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Slotted Dumbbell Shaped Microstrip Patch Antenna for Wi-Max Frequency Band of 3.4-3.69 GHZ

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Abstract-This article presents a design for Rectangular microstrip patch antenna by cutting dumbell shaped slot in the rectanglar patch.Using probe feeding technique we have found the optimum feed point giving desired results.The electromagnetic simulation of the proposed antenna has been carried out using IE3D software which work on principle of Method of Moment. Return loss, VSWR, antenna efficiency and radiation pattern etc can be evaluated for given design.

Keywords- Dumbell slotted microstrip patch antenna for wimax, return loss, VSWR, antenna efficiency.

I. INTRODUCTION

Present and future trend in communication design is towards the miniaturization of the devices same is the case with antenna technology. Present scenario demands low profile antenna structures for e.g. in wireless communication the communicating device such as cell phones are small enough to be carried out easily, so the antenna used in such devices should be small but not at the cost of the performance of the antenna.. Micro-strip patch antenna have low cost of fabrication and small structures. Micro-strip antenna was first proposed by G.A. Deschamps in 1953. Since patch antennas can be directly printed onto a circuit board, these are becoming increasingly popular within the mobile phone market. One of the key drawbacks of such device is their narrow bandwidth.. Significant amount of research and study is being carried out to determine the augment in gain and bandwidth of the micro strip patch antenna by using probe feed stacked antenna, slotted patch antenna and stacked shorted patches. Any wireless communication needs high gain and if the bandwidth of the antenna is also increased along with the gain it will be an additional advantage, though enhancing both gain as well as bandwidth at a same time is a challenging task.

II. ANTENNA DESIGN

The proposed antenna structure is designed by cutting a dumbbell shaped slot of fixed dimensions. Cutting of this slot in antenna increases the current path which increases current intensity as a result efficiency is increased and desired parameters are obtained. Start off by calculating basic equation of typical rectangular patch and then convert its equivalent area to a Rectangular form. The Essential parameters of this Rectangular microstrip patch antenna are W= 33.88mm,L= 27.90mm,Length of ground plane=38.70,Width of ground plane=44.68155.

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The rectangular microstrip patch antenna designed on one side of glass/epoxy structure with εr = 2.2,height from the ground plane d= 1.8mm and loss tangent=0.0009.Design is being calculated taking frequency 3.5GHz and it is shown in figure (1).
Steps for calculating the dimension of patch[10]

Step 1: Calculation of the Width (*W*):
The width of the Microstrip patch antenna is given as:

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

Substituting c = 3.00e+008 m/s, εr = 2.2 and fo = 3.5 GHz, we get:
***W* = 0.03388 m = 33.88 mm**

Step 2: Calculation of Effective dielectric constant (*εreff*):
The effective dielectric constant is:

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Substituting εr = 2.2, W = 33.88 mm and h = 1.8 mm we get:
εreff = **2.0688**

Step 3: Calculation of the Effective length (*Leff*):
The effective length is:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Substituting $\varepsilon reff$ = 2.0688, c = 3.00e+008 m/s and fo = 3.5 GHz we get:
Leff **= 0.02979 m = 29.79 mm**

Step 4: Calculation of the length extension (Δ*L*):
The length extension is:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

Substituting $\varepsilon reff$ = 2.0688, W = 33.88 mm and h = 1.8 mm we get:
Δ*L* = 0.94 mm

Step 5: Calculation of actual length of patch (*L*):
The actual length is obtained by:

$$L = L_{eff} - 2\Delta L$$

Substituting $Leff$ = 29.79 mm and ΔL = 0.94 mm we get:
***L* = 27.90 mm**

Step 6: Calculation of the ground plane dimensions (*Lg* and *Wg*):
The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by [9] that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch.

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dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:

$Lg = 6h + L = 6(1.8) + 27.90 = 38.70$ mm

$Wg = 6h + W = 6(1.8) + 33.88 = 44.68$ mm

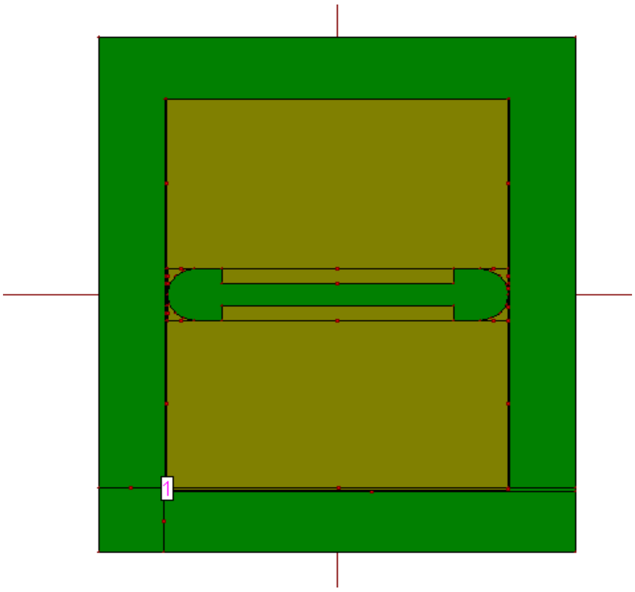

Figure (1): Proposed Rectangular Micro-strip Patch Antenna with Dumbbell shaped slot with feed point at (-13.8,-16.8).

III. ANTENNA RESULT

The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for a slotted dumbbell shaped patch antenna is shown in figure (2) . The VSWR indicates the mismatch between the antenna and the transmission line. For perfect matching the VSWR value should be close to unity. The VSWR for this slotted antenna is 1.05. The simulated radiation pattern in 3D are shown in figure (3), the return loss graph is shown in figure (4) and it is -31.43 dB, the total field gain & frequency is shown in figure (5), the antenna efficiency & frequency is shown in figure (6),

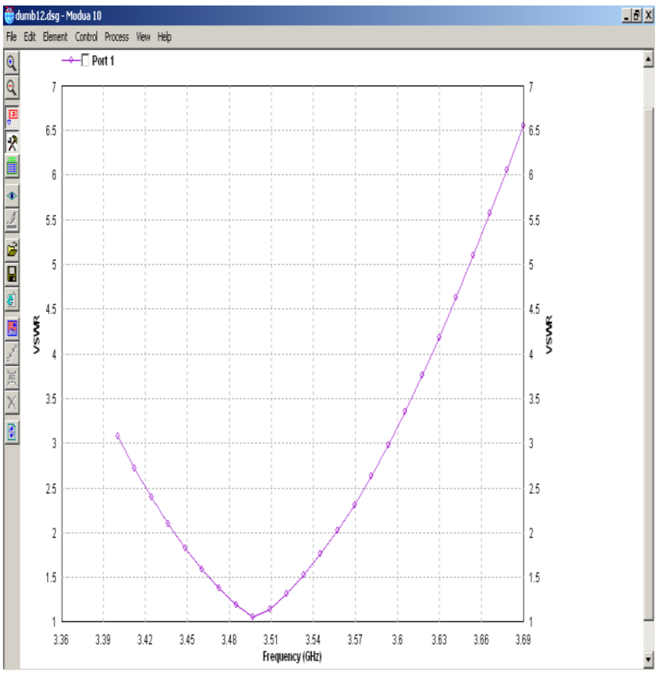

Figure (2): VSWR of the Proposed Antenna = 1.05 at 3.49Ghz

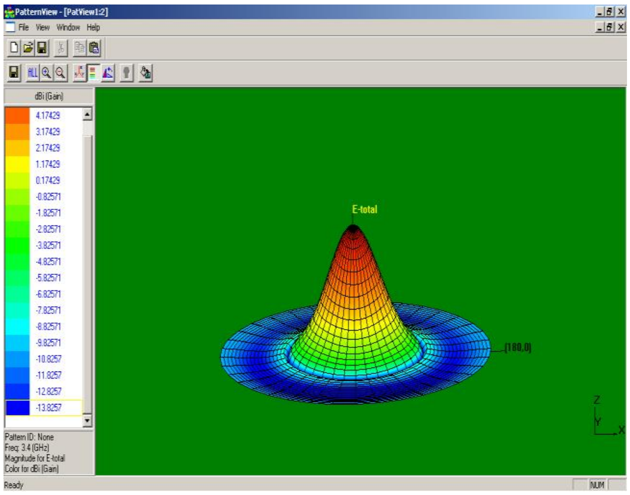

Figure (3): Radiation pattern in 3D of the Proposed Antenna

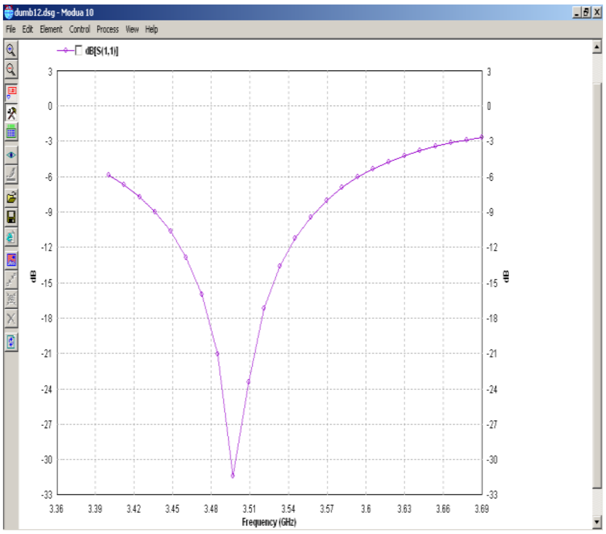

Figure (4): Return Loss of the Proposed Antenna = -31.43 db at 3.49Ghz

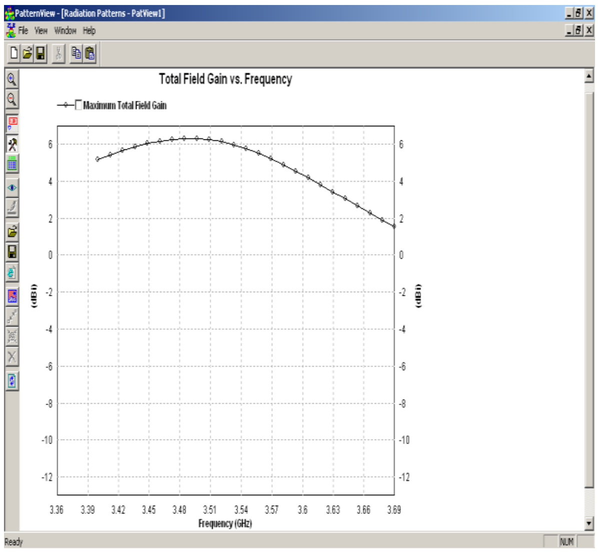

Figure (5): Total field gain & frequency of proposed antenna=6.31 at 3.49Ghz

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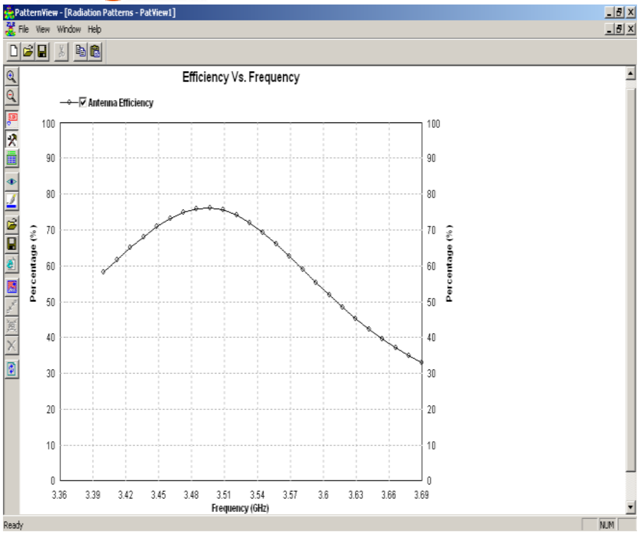

Figure (6): Antenna efficiency & Frequency of proposed antenna=77

IV. CONCLUSION

From the detailed experimental study it is concluded that a probe feed, slotted micro-strip patch antennas can be designed efficiently to give the desired results. The proposed antenna has a compact size of (27.9 x 33.88 x1.8) and it can effectively cover Wireless operations like Wi-Max.

REFERENCES

[1]. M. K. Verma, Sapna Verma, and D. C. Dhubkarya, “Analysis and Designing of E-Shape Microstrip Patch Antenna for the Wireless Communication Systems”, International Conference on Emerging Trends in Electronic and Photonic Devices & Systems (ELECTRO-2009), 2009.

[2]. Arny Adila Salwa Ali and Sharlene Thiagarajah, “A Review on MIMO Antennas Employing Diversity Techniques”.Proceedings of the International Conference on Electrical Engineering and Informatics Institut Teknologi Bandung, Indonesia June 17-19, 2007.

[3]. Ramesh Gerg, Prakash Bhartia, Indar Bhal & Apisak Ittipiboon, “Microstrip Antenna Design Handbook”, Artech House, London, 2001.

[4]. Jitesh kumar, Sarthak singh , Sakshi singh, , “ Multiple nonagon void slotted micro strip patch antenna” International Journal of engineering and advance technology. (IJEAT) Volume 2, Issue 5, june 2013 ISSN 2249-8958.

[5]. Nasimuddin and Z. N. Chen, “Wideband multilayered microstrip antennas fed by coplanar waveguide-loop with and without via combinations,” IET Microw. Antennas Propag., vol. 3, pp. 85–91, 2009.

[6]. J. S. Colburn and Y. Rahmat-Samii, “Patch antennas on externally perforated high dielectric constant Substrates *IEEE Trans. Antennas Propag.*,, vol. 47, no. 12, pp 1785–1794, 1999.

[7]. Kuo, Y. L. and K. L. Wong, Printed double- T monopole antenna for 2.4/5.2 GHz dual-band WLAN operations," *IEEE Trans. Antennas Propag.*, Vol. 51, No. 9, 2187-2192.

[8]. Balanis, C.A., Advanced Engineering Electromagnetics, John Wiley & Sons, New York, 1989.

[9]. Zeland Software Inc. IE3D: MoM-Based EM Simulator. Web: http://www.zeland.com/

[10] C. A. Balanis, “Antenna Theory, Analysis and Design,” John Wiley & Sons, New York, 1997.

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